CHEMISTRY

Make Your Own Acid-Base Indicator

INTRODUCTION

Acid-base indicators change color in acidic or basic environments. They can be synthetic (like phenolphthalein) or natural (from plants). In this activity, we'll make natural indicators using turmeric, red cabbage, beetroot, and periwinkle flower extracts and test them on household items.

MATERIALS REQUIRED

1. 1 Laminated coloured printed sheet
2. 1 Laminated printed sheet
3. Muslin cloth *
4. Plastic funnel *
5. Porcelain mortar and pestle *
6. DI water (300 mL) *
7. 30 mL Plastic dropper bottle *
8. Plastic pipettes *
9. Test tubes *
10. Turmeric powder *
11. Citric acid *
12. Baking Soda *
13. Spatula *
14. 1M NaOH (20 mL) *

Asterisk (*) sign items are in the common material kit.

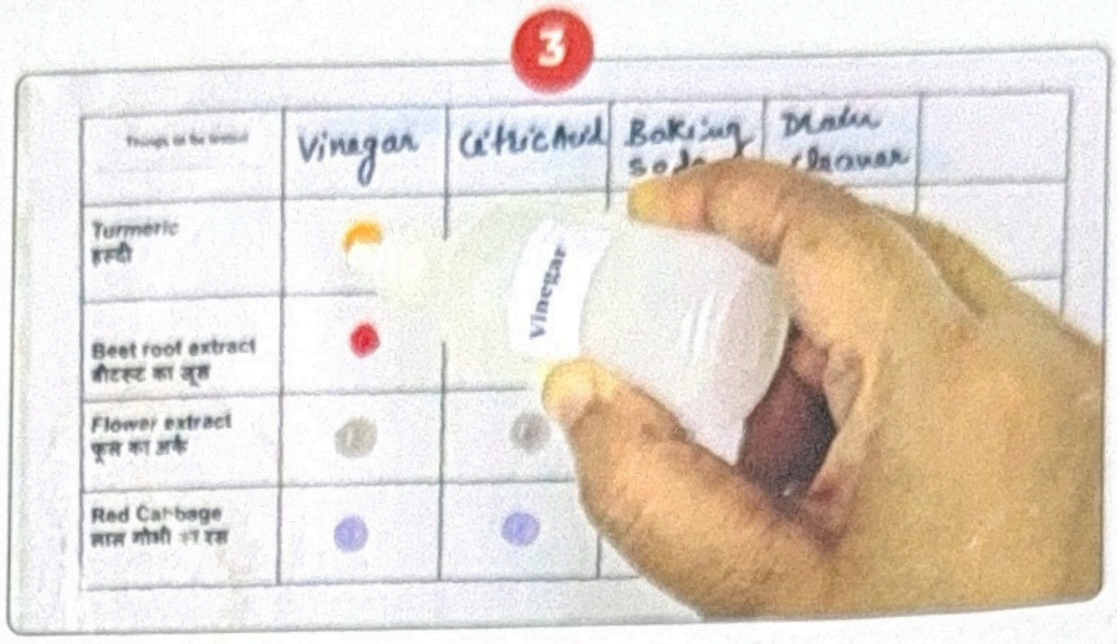
Bal Bharati PUBLIC SCHOOL
Gangaram Hospital Marg, New Delhi-110060

ChemSparks
An Innovative Chemistry Workshop

INSTRUCTIONS

Making of Test solutions:

- **Citric Acid:** Dissolve 1 spatula of citric acid in 20 mL water.
- **Baking Soda:** Dissolve 1 spatula of baking soda in 20 mL water.
- **Drain Cleaner (or NaOH):** Dissolve 1 spatula of drain cleaner/NaOH in 20 mL water (handle with care).
- **Vinegar:** Use as is.



Apply a drop of each indicator to the labeled boxes on the laminated sheet. According to the labels mentioned in the sheet, add a single drop of each test solution on the drop of indicator. Observe the color changes, then compare them to the reference sheet to identify the pH and determine which solutions are acidic or basic.

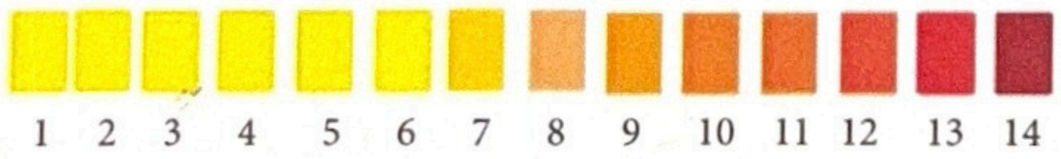
WHAT'S HAPPENING?

Observation table:

	Citric Acid Solution	Vinegar	HCl Solution	Na_2CO_3 Solution
Turmeric				
Red cabbage				
Periwinkle extract				
Beet root				
Acidic/Basic				

Turmeric indicator :

In the boxes where baking soda and drain cleaner are added to turmeric indicator drops, a red color is observed. Conversely, in the boxes where vinegar and citric acid are added, no color change is observed.
Turmeric is an acid-base indicator, having a chemical called curcumin, which remains yellow in an acidic or neutral solution, but turns red in a base. This red color can be changed back to yellow when an acid is added into this solution.



Red cabbage & Periwinkle flower (Catharanthus roseus) indicator:

The red cabbage and periwinkle extracts act as an acid-base indicator due to the presence of anthocyanin compounds. These extracts change colors such as red, pink ,blue, purple, green and yellow in various acidic and basic solutions of different pH.

Beet root indicator:

Beetroot contains betanin, giving its aqueous solution a bright red color. In an acidic medium, it turns reddish-brown (burgundy). At pH 8-9, it shifts to brownish-purple. When the pH reaches 12-14, betanin undergoes hydrolysis, turning the solution yellow.

CHEMISTRY

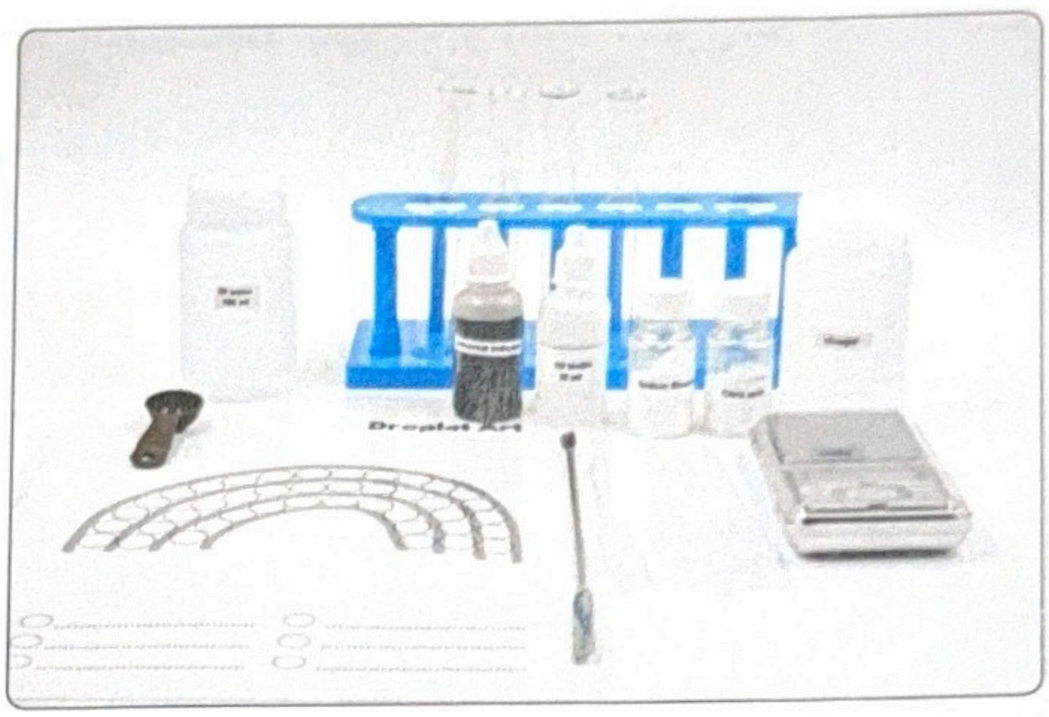
Indicator Droplet Art

INTRODUCTION

In this colourful experiment, we'll use droplets of various acids and bases along with a universal pH indicator to create vibrant art. As the pH shifts, the indicator changes colour, showcasing a spectrum of hues from simple household substances. This interaction not only highlights the science behind acid-base chemistry but also transforms it into a stunning visual display, blending scientific discovery with artistic creativity.

MATERIALS REQUIRED

1. Laminated printed sheets
2. Sodium bicarbonate ($NaHCO_3$) Solution .
3. Citric acid Solution
4. 1M NaOH (30 mL)
5. 4 Plastic droppers
6. Vinegar (10 mL)
7. Universal Indicator (20 mL) *
8. 4 Test tubes *
9. Test tube stand *
10. DI water (60 mL) *
11. Digital weighing scale *
12. 1 Micro steel spatula *



Asterisk (*) sign items are in the common material kit.

SAFETY GUIDE

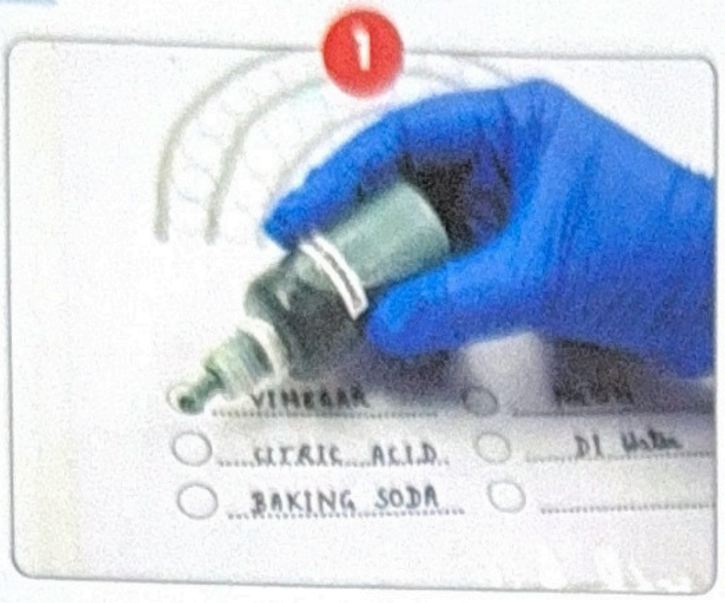
Wear safety goggles while performing this activity. NaOH or drain cleaner is corrosive and should be only handled while wearing gloves. Universal indicator is flammable and must be kept away from sources of fire.

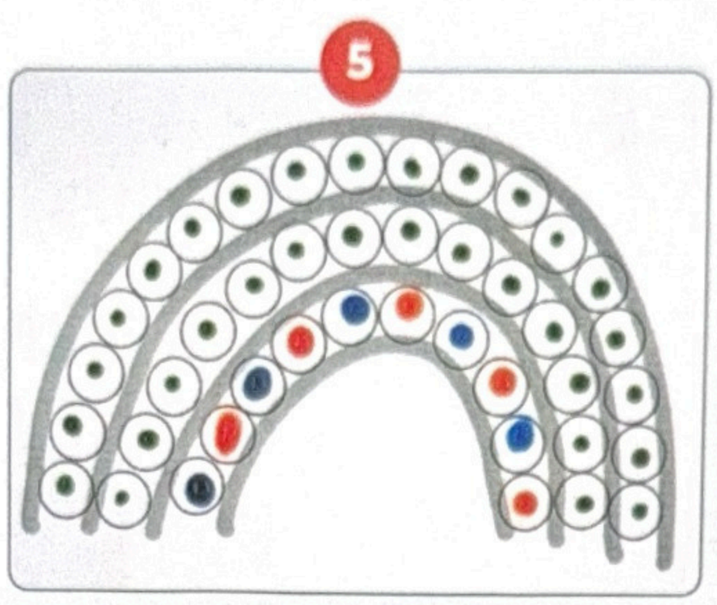
INSTRUCTIONS

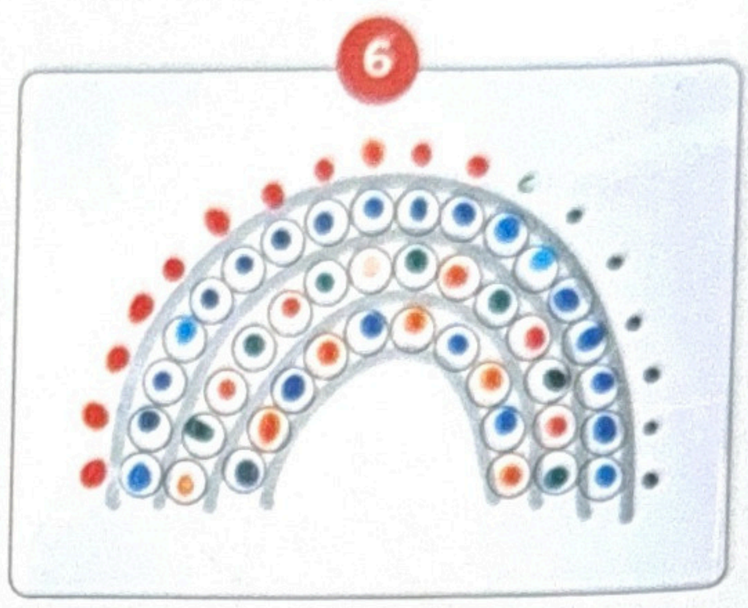
Performing the activity:

- Take the laminated art sheet and label each circle in the colour palette with the following test solutions: 1. Vinegar, 2. Citric acid, 3. Sodium bicarbonate, 4. Sodium hydroxide, 5. DI/tap water. (You can also use lemon water, washing powder, toothpaste, or liquid soap.)
- Place a drop of universal indicator in each labelled circle. (You can also substitute with natural indicators like turmeric, red cabbage, beetroot, or flower extracts.)
- Add a drop of the corresponding test solution on top of the universal indicator in each circle. Observe the colour change!
- Next, move to the design section of the sheet. Add the universal indicator drops into each circle of the design, ensuring they are slightly smaller than the circles to allow space for the test solutions.
- Refer to the colour palette to choose the appropriate test solution, then place a drop on top of each indicator drop. Feel free to place different test solutions in various spots on the design to enhance its colour and appeal. And just like that, your artwork is complete!

INSTRUCTIONS







WHAT'S HAPPENING?

Observation:

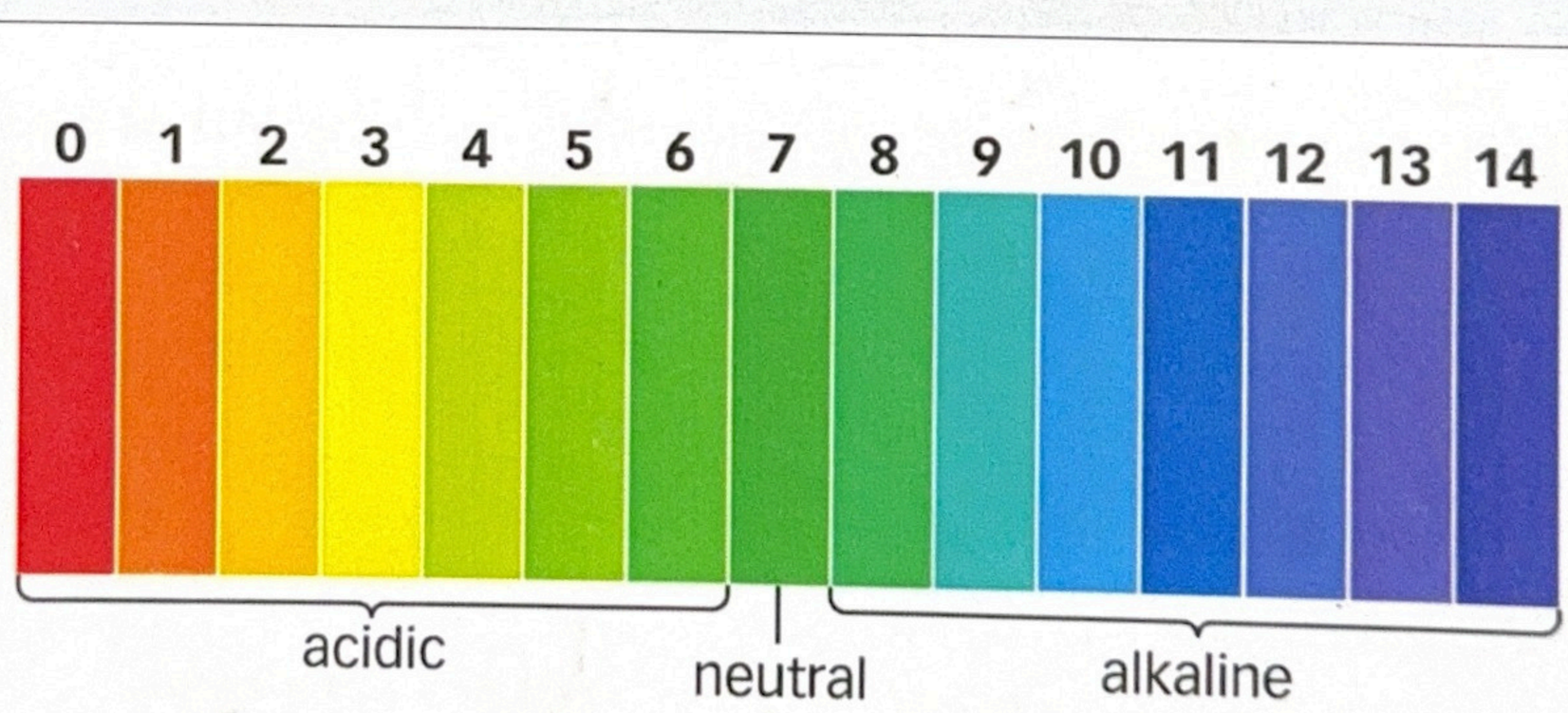
The colours change because the universal indicator reacts to the nature of each solution:

- Tap water stays green (neutral).
- Vinegar turns red (acidic).
- Citric acid turns orange (acidic).
- Sodium carbonate turns blue (basic).
- NaOH turns purple (basic).

Hydrochloric acid turns red (acidic).

Explanation:

A universal indicator is a mixture of compounds that change colour over a range of pH values, revealing a solution's acidity or basicity. By using this property, we can create colourful art with drops of acids, bases, and neutral solutions.



pH Chart for Universal Indicator

CHEMISTRY

Lava Lamp

INTRODUCTION

In this experiment, we create a visually captivating lava lamp. We will mix some household materials resulting in formation of gas bubbles that rise and fall through the oil creating a colorful, lava lamp-like effect.

MATERIALS REQUIRED

1. Vegetable oil (60 mL)
2. Sodium bicarbonate ($NaHCO_3$), (10 gm)
3. Food colour
4. Acetic acid Solution
5. Plastic dropper *
6. Digital weighing scale
7. Plastic spatula *
8. Plastic measuring cylinder (50 mL) *
9. Plastic beaker (50 mL) *
10. Glass test tubes *
11. Glass beaker (100 mL) *

Asterisk (*) sign items are in the common material kit.

SAFETY GUIDE

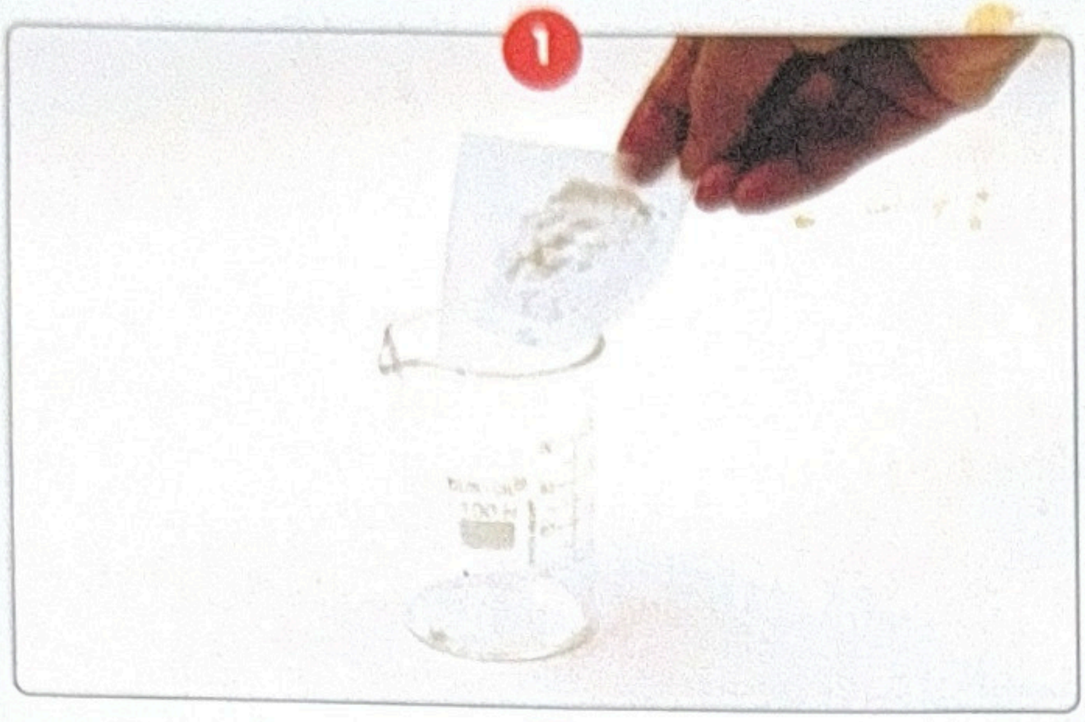
Wear safety gloves and safety goggles while handling vinegar

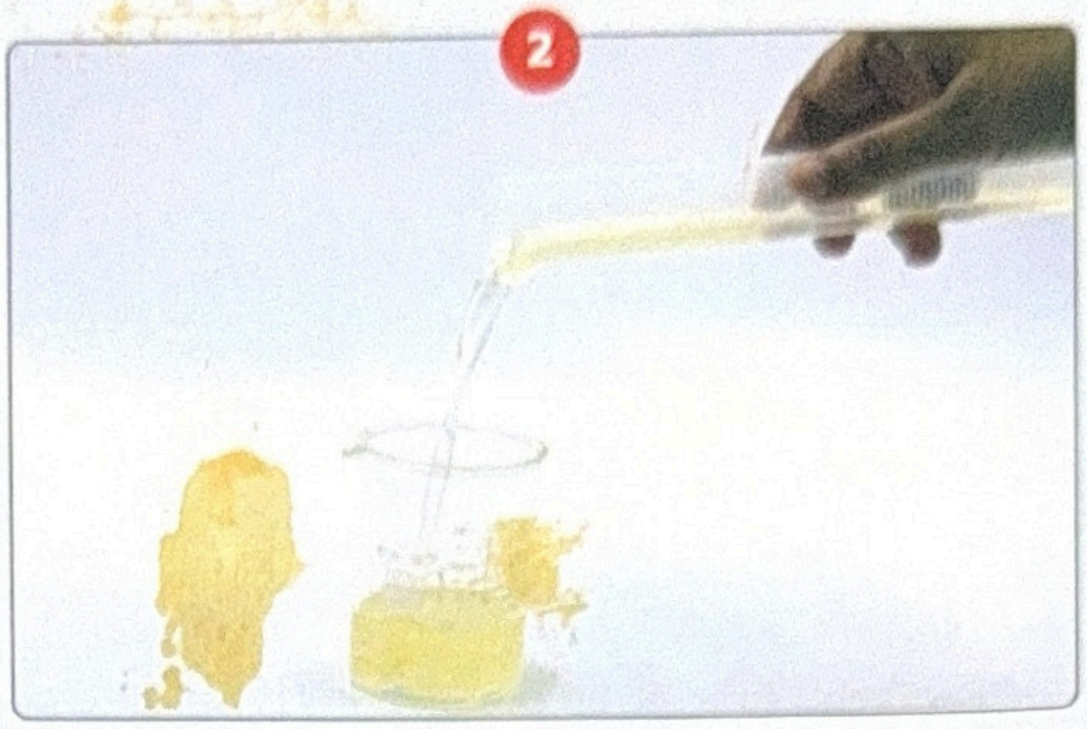
INSTRUCTIONS

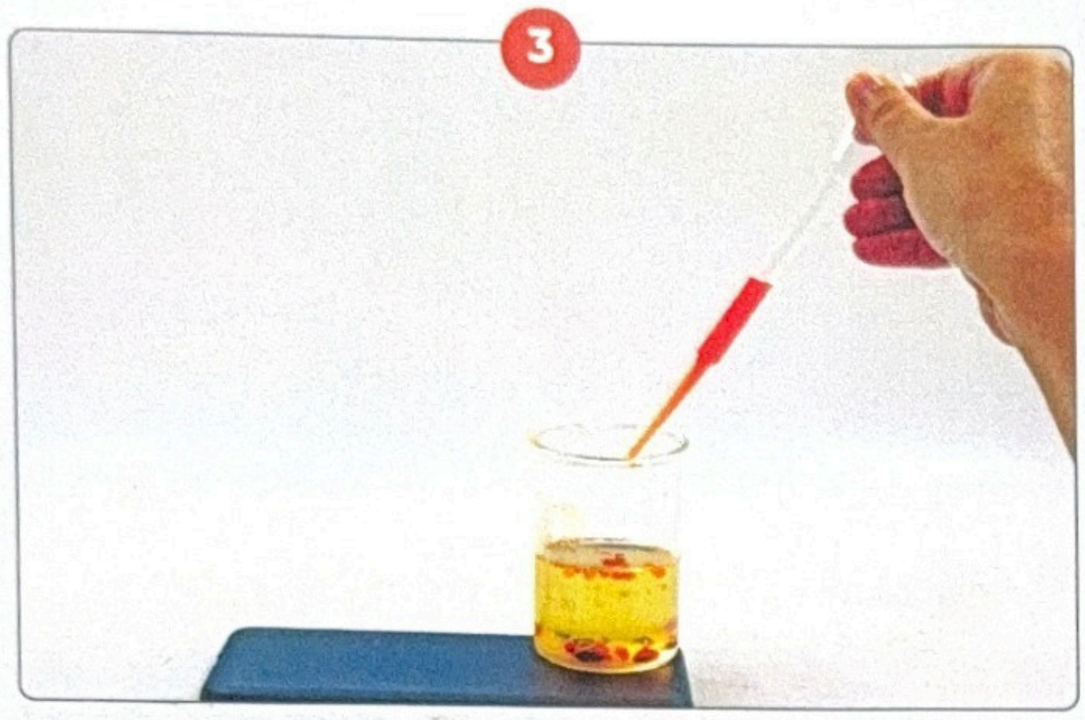
- Add 5 gm of baking soda in a 100 mL borosilicate glass beaker.
- Fill the ¾ height of the beaker with oil.
- In another container, take 5 mL of vinegar and mix a few drops of food colour in it.
- With the help of a dropper add a few drops of the above mixture in the glass beaker filled with oil.
- Keep a light source below the beaker such as torch light or mobile's light and record the observations.

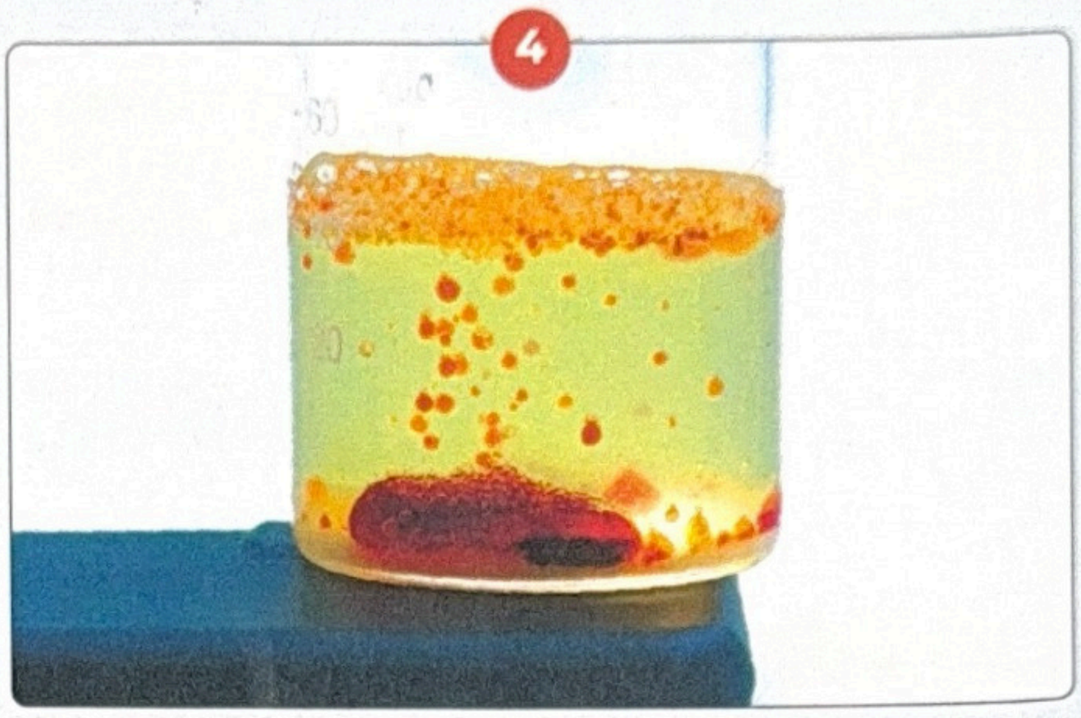
Questions	Observation
On adding the drops of vinegar + food color into the oil, what do you observe?	
The drop of vinegar + food colour reaches the bottom of the beaker, what happens next?	
Do you observe any bubbles? What could these bubbles be made of?	
Do you see the bubbles settled at the bottom? If not, what pattern do you see?	

INSTRUCTIONS









WHAT'S HAPPENING?

Observation:

Colorful bubbles are seen coming up and sinking down repeatedly. Due to these floating colorful bubbles, it is known as lava lamp.

Explanation:

When we start adding vinegar (which is a combination of acetic acid and water) on the top of the oil in the glass beaker, it starts going down as it is denser than oil. Once the vinegar reaches the bottom, it starts reacting with baking soda at the bottom. In this reaction, products such as CO_2 gas, water and sodium acetate are formed.

$$CH_3COOH_{(aq)} + NaHCO_{3\,(aq)} \rightarrow CH_3COONa_{(aq)} + H_2O_{(l)} + CO_{2\,(g)}$$

As CO_2 gas accumulates in the bottom, some drops of water soluble dye, vinegar and sodium acetate also get trapped in it and a bubble is formed which has less density than water. Most of the bubbles formed are less dense than the oil which makes them float up. These bubbles reach the surface and pop. CO_2 gas releases and the rest of the bubbles become more dense than the oil and start sinking.

When the sinking bubbles (containing remaining gas, some water, oil, unreacted vinegar and probably some sodium acetate) touch the bottom, the vinegar trapped in the bubbles react with unreacted sodium bicarbonate at the bottom of the beaker and forms carbon-dioxide.

This suggests that the acid-base reaction restarts, producing bubbles. The bubbles keep rising and sinking because the remaining vinegar and baking soda keep reacting and generating more CO_2 gas till either of the reactants gets consumed fully. The trapped dye in the bubbles creates colorful patterns as they move through the oil, enhancing the visual effect. Thus, the interplay of density changes and constant reactions creates the mesmerizing, lava lamp effect where vibrant bubbles float up and down.

CHEMISTRY

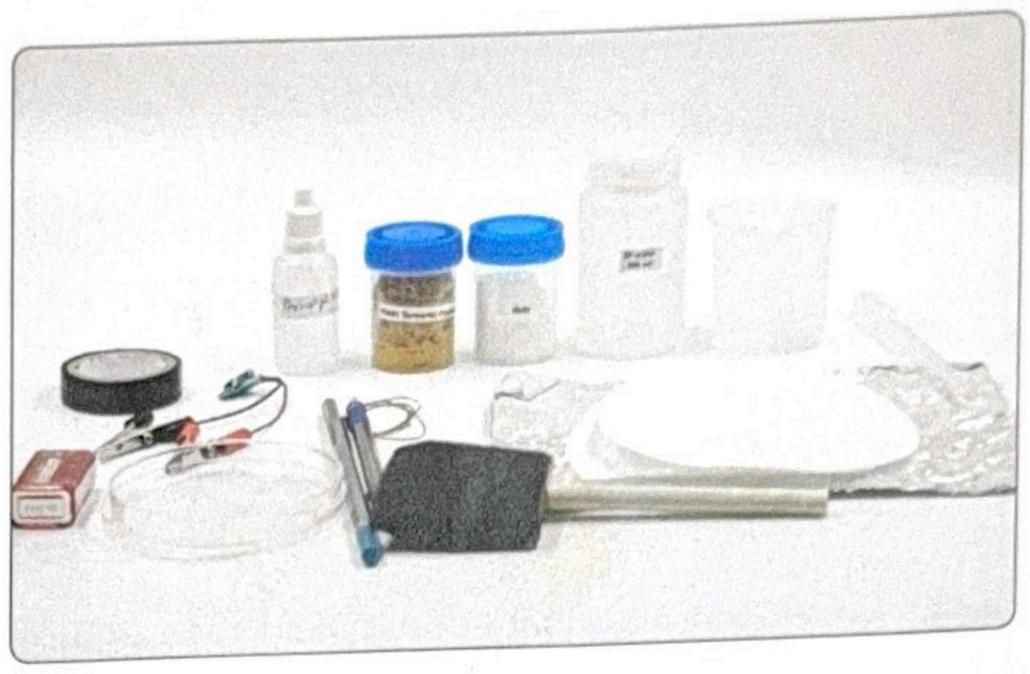
Electrolytic Writing

INTRODUCTION

Have you ever thought of a pen which could write without any ink? This might seem like magic, but we can do this with the help of chemistry. In this activity, we will utilize the phenomenon of electrolysis (splitting of water) to write on a canvas with a pen devoid of any ink.

MATERIALS REQUIRED

1. A5 size aluminum foil (2 pieces)
2. Empty plastic pen with copper wire
3. Pencil
4. Salt (1 teaspoon) *
5. Water (50mL) *
6. 50 mL beaker *
7. 1 Petri Dish *
8. 1 Brush *
9. Phenolphthalein indicator *
10. Turmeric powder (1 teaspoon) *
11. 1 Plastic dropper *
12. 2 Filter papers *
13. 2 Crocodile clips *
14. One 9 Volt battery with snappers
15. Electric tape *



Asterisk (*) sign items are in the common material kit.

SAFETY GUIDE

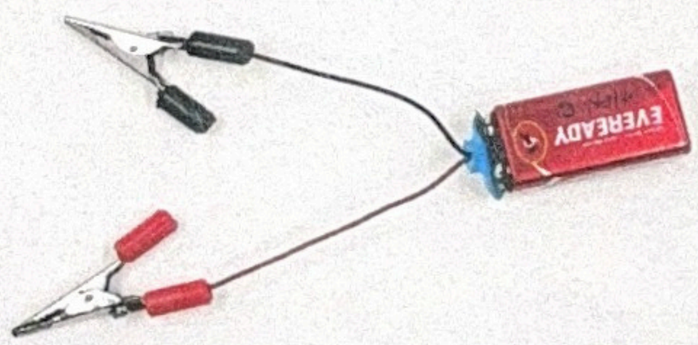
Phenolphthalein causes serious eye irritation, it may cause drowsiness or dizziness. Wear safety goggles and safety gloves.

INSTRUCTIONS

Preparing the battery

- Connect the red crocodile clip with the red wire of the snapper and connect black crocodile clip to the black wire of the snapper.
- Connect the snapper to the battery (Kindly note that the red crocodile clip is attached to the positive terminal of the battery and black crocodile clip is attached to the negative terminal of the battery).

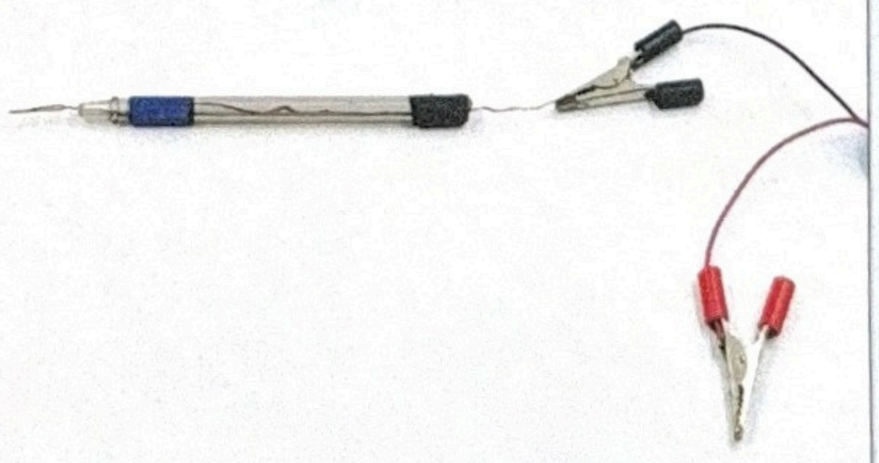
1



Making of pen:

- Take out the refill from the pen and drill or puncture a small hole at the back side/ back cap of the pen.
- Take a piece of wire and insert it through the hole made in the back of the pen, extending it all the way through the front opening of the pen.
- Strip the insulation from both the tip and the back end of the wire.
- Tie a knot on the back part and wrap it around the pen so that wire remains in its position. Similarly, just bend the wire on the front end to make a nib of our pen.

2

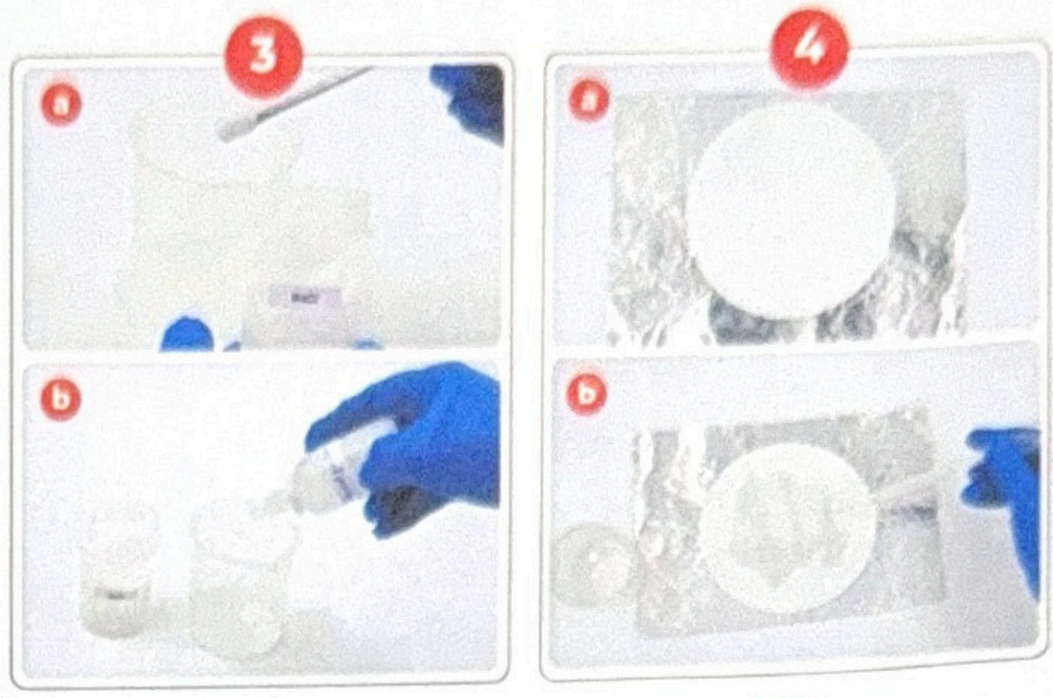


INSTRUCTIONS

Making the Canvas

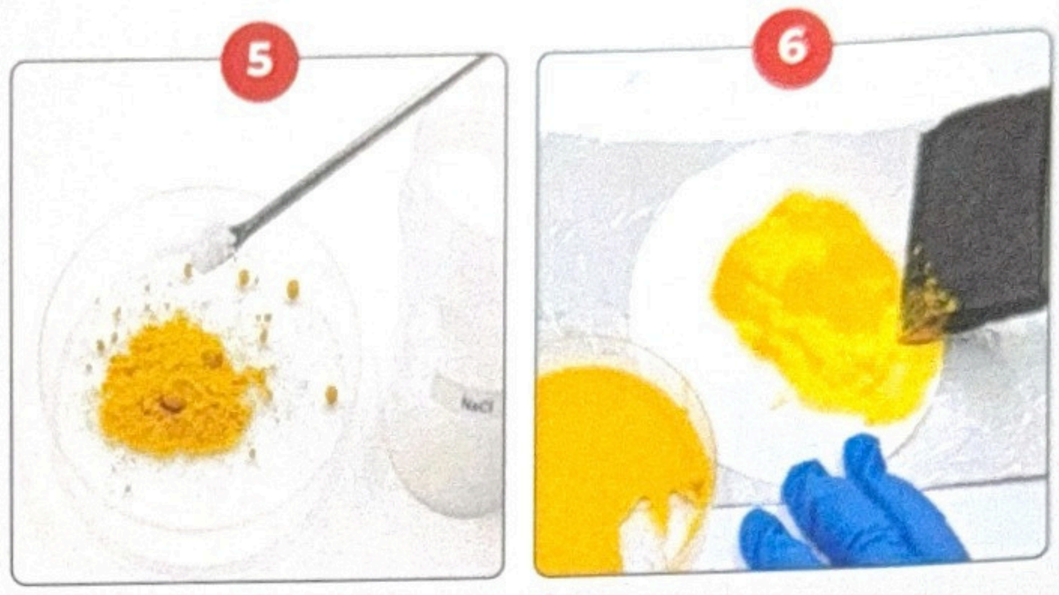
Canvas 1:

- Take 25 ml DI water in a 50 ml beaker and dissolve 3 gm of salt to make a salt solution (Fig. 3.a).
- Add a few drops of phenolphthalein to the salt solution (Fig. 3.b).
- Place a filter paper on top of the aluminum foil (Fig. 4.a).
- Dampen the filter paper with the prepared solution (Fig. 4.b).



Canvas 2:

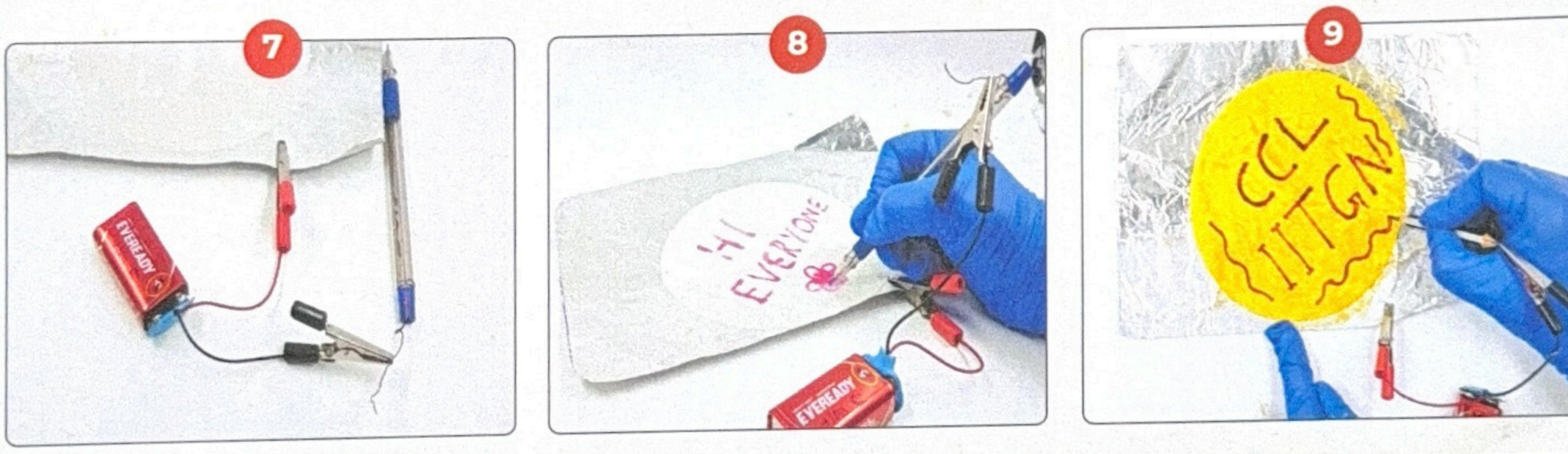
- Take 1 teaspoon of turmeric in a petri dish, add 1 gm of salt and DI water in it and make a paste (Fig. 5)
- Place a filter paper on top of the aluminum foil (Fig. 4.a).
- Then, using a foam brush, apply turmeric paste to this filter paper (Fig. 6).



Writing on canvas:

Connect the black crocodile clip (negative terminal) to the pen and red crocodile clip (positive terminal) to the aluminum foil. Use the pen connected to the negative terminal of the battery to write or draw something on the top of the filter paper.

Observe the color of writing in both filter papers.



WHAT'S HAPPENING?

Observation:

The writing in the first filter paper will appear in pink, whereas in the second filter paper coated with turmeric paste, the writing appears red in color.

Explanation:

Phenolphthalein and turmeric are acid-base indicators which change colour in presence of base. When the battery's negative terminal is connected to the pen and the positive terminal to the aluminum foil, the electrical circuit gets complete i.e, a direct electric current is passed through a solution. As a result of this, some water molecules split into H^+ and OH^- ions and this process is known as electrolysis. The OH^- ions start getting accumulated around the contact of the tip making the area basic resulting in pink writing in case of phenolphthalein and red in case of turmeric.

CHEMISTRY

Rainbow Fizz

INTRODUCTION

In this neutralization reaction activity, where a carbonate is used as the base, carbon dioxide bubbles are released. As the reaction unfolds, a spectrum of colors appears, representing different pH levels. This vibrant display is what gives the experiment its name "Rainbow Fizz."

MATERIALS REQUIRED

1. Sodium carbonate (2.5 gm)
2. 0.1 M acetic acid (25 mL)
3. Universal Indicator (20 mL) *
4. Plastic dropper (3 pieces) *
5. Glass test tubes (2 pieces) *
6. DI water (100 mL) *
7. Digital weighing scale *
8. Plastic measuring cylinder (50 mL) *
9. Micro steel Spatula *

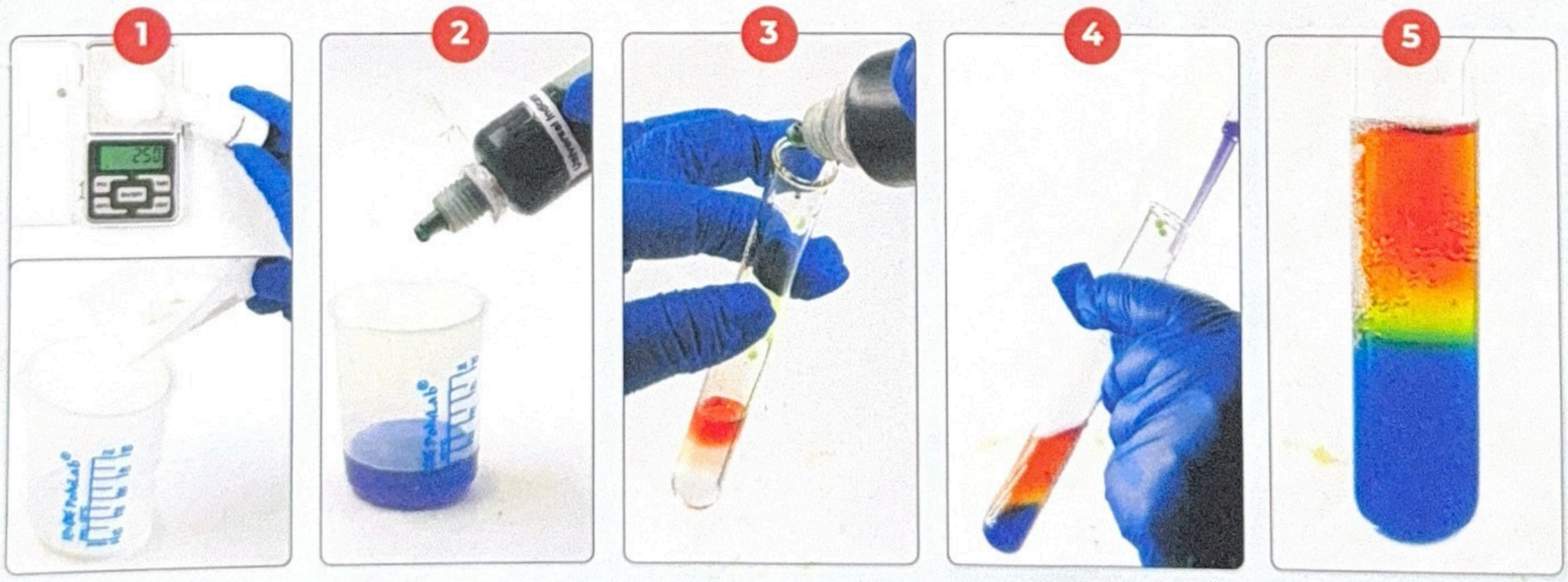
i Asterisk (*) sign items are in the common material kit.

SAFETY GUIDE

- Wear gloves and safety goggles while performing the experiment.
- Universal indicator solution is highly flammable and must be kept away from sources of fire.

INSTRUCTIONS

- Dissolve 2.5 grams of sodium carbonate (Na_2CO_3) in 10 ml of water and add to a test tube.
  Add 5-6 drops of Universal Indicator (UI) to the solution, which will turn purple.
- Take approx 5 ml of 0.1 M acetic acid in a test tube and add 3-4 drops of UI.
  The solution will turn red in colour.
- Slant the test tube containing acetic acid + UI and slowly add 3 ml of sodium carbonate (Na_2CO_3) solution using a dropper pipette from the side of the test tube.
- Observe and record the changes in each step.



WHAT'S HAPPENING?

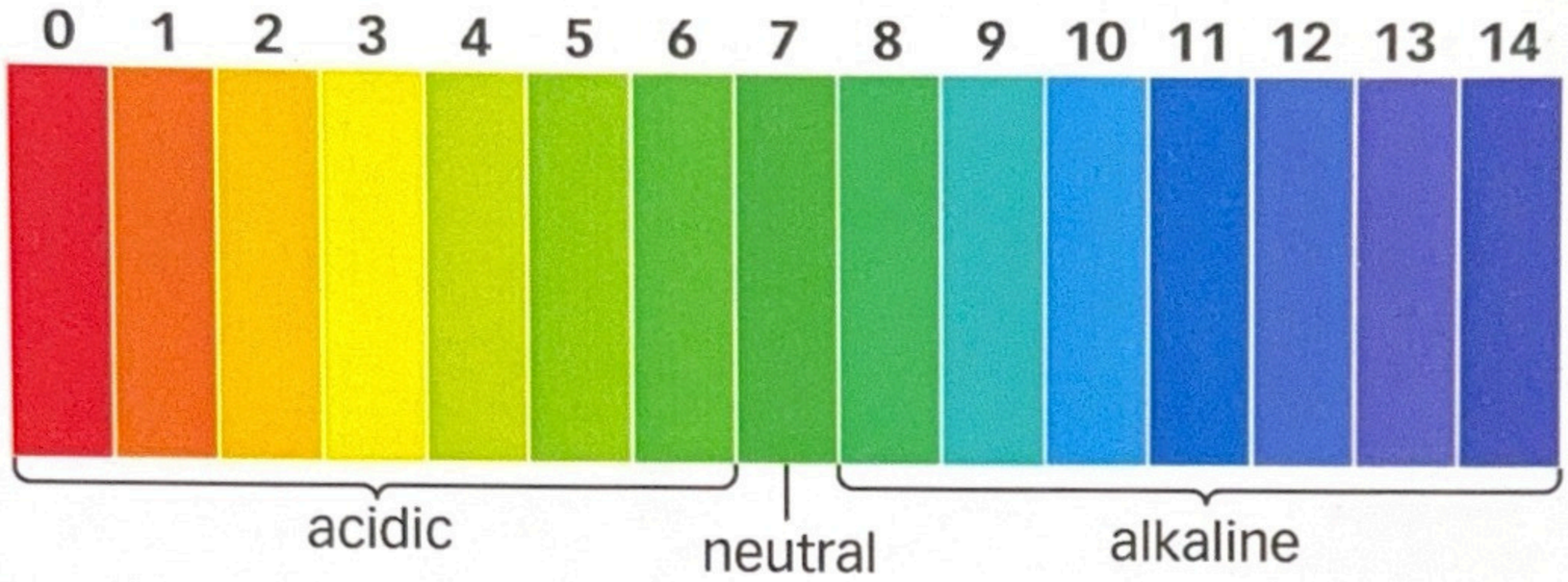
Observation:

A vibrant rainbow of colors is observed in the test tube, with a purple zone at the bottom, followed by blue, green, yellow, orange, and an orangish-red zone at the top. Also bubbles are observed originating at the green zone in the test tube.

Explanation:

In this activity, a 'rainbow' is produced showing the range of colors produced by the universal indicator. Universal indicator changes its colour when added to acidic or basic medium and shows a range of colours across the pH scale.

The pH scale is a tool for determining how acidic or basic a solution is. It ranges from pH 0 (highly acidic) to pH 7 (neutral) and up to pH 14 (highly basic). Distilled (pure) water has a neutral pH of 7. The figure below demonstrates how different pH values correspond to specific color changes in a universal indicator, reflecting the varying acidity or basicity of solutions across the pH scale, which ranges from 0 to 14.



pH Chart for Universal Indicator

Initially, on adding a few drops of Universal Indicator (UI) in the acetic acid solution, the solution becomes orange red in colour indicating that the solution's pH is around 1-2.
In step 2, on adding a few drops of universal indicator in the sodium carbonate solution, the colour of the solution turns violet purple indicating that the pH of the solution is >12.
In step 3, when we add sodium carbonate solution on top of acetic acid, sodium carbonate solution gradually starts to sink at the bottom as it is denser than acetic acid.

The sodium carbonate at the bottom remains unreacted, retaining its purple colour. As it sinks, some of the sodium carbonate reacts with acetic acid to form sodium bicarbonate, which has a pH range of 8.5.
In this pH range, the universal indicator makes a blue colour zone .

$Na_2CO_3 + CH_3COOH \rightarrow NaHCO_3 + CH_3COONa$

Above this, a neutralization zone is visible at the interface where acetic acid has reacted completely with sodium carbonate or recently formed sodium bicarbonate to form sodium acetate, water and carbon dioxide. This complete neutralization results in a color change of the universal indicator to green. Carbon dioxide gas (CO_2) bubbles formed are seen in this green neutralization zone.

$Na_2CO_3 + 2CH_3COOH \rightarrow 2CH_3COONa + H_2O + CO_{2(g)}$

Other Possible reaction :

$NaHCO_3 + CH_3COOH \rightarrow CH_3COONa + H_2O + CO_{2(g)}$

Above this, the universal indicator shows a greenish-yellow color, indicating a pH of 3-4. In the top layer, where acetic acid remains unreacted, an orange-red color zone persists.
As a result, a rainbow effect is observed, caused by the formation of various products with differing pH values and densities that create distinct color zones, resulting in a visually captivating display.

Experiment 6: pH Titration

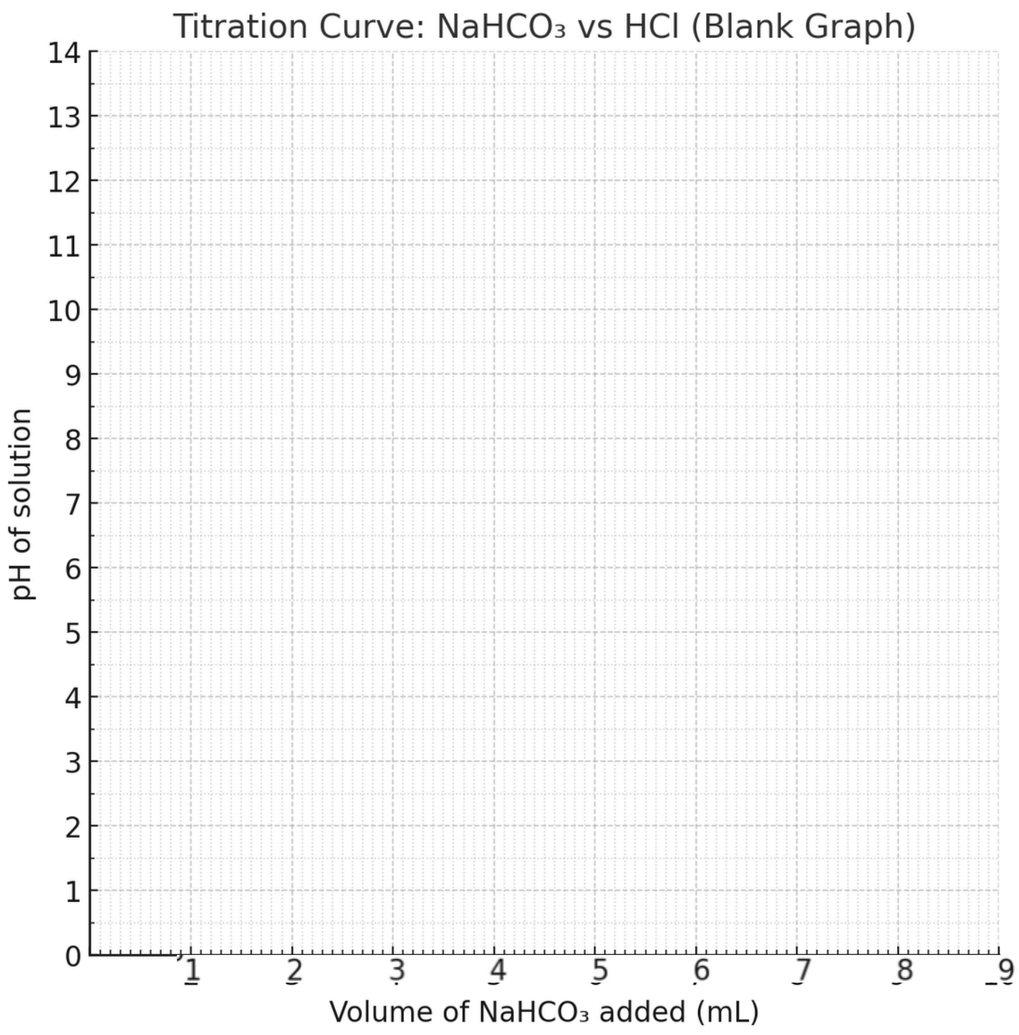
Aim:
To determine the endpoint of an acid–base titration using an indicator.

Materials Required:
- Burette, pipette, conical flask
- 1M $NaHCO_3$ solution
- 1M HCl acid solution
- Universal indicator
- Distilled water

Procedure:
1. Rinse the burette with distilled water then fill it with $NaHCO_3$ solution.
2. Use a pipette to transfer a measured volume of HCl solution into the conical flask.
3. Add 2–3 drops of universal indicator to the acid.
4. Titrate by adding $NaHCO_3$ dropwise, swirling the flask continuously.
5. Stop when the solution just turns faint pink. Record the burette reading.
6. Repeat until concordant readings are obtained.

Observation:
- Initial burette reading: _____ mL
- Final burette reading: _____ mL
- Volume of $NaHCO_3$ used: _____ mL

Result: The endpoint is reached when the solution changes from colourless to pale pink, indicating neutralization



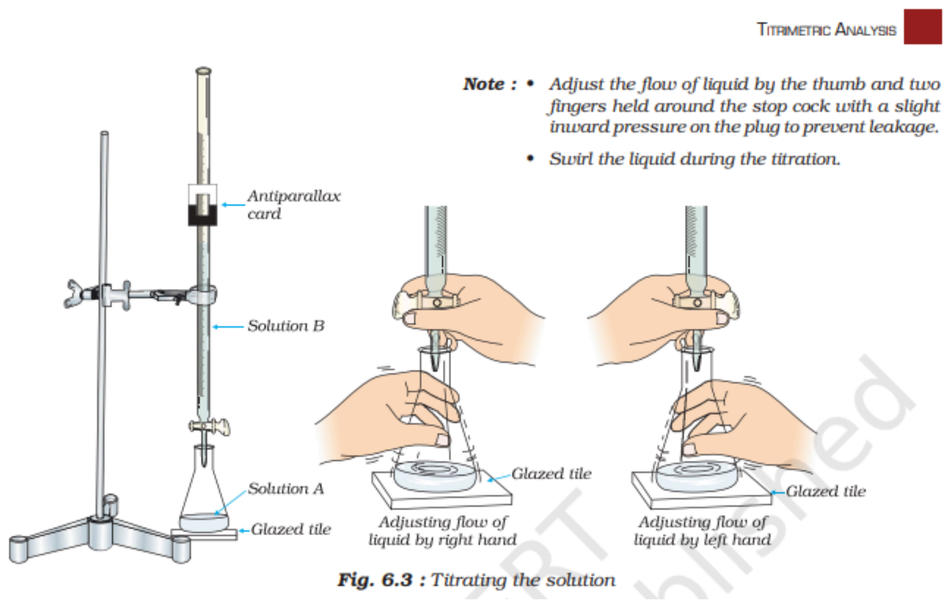


Fig. 6.3 : Titrating the solution

Experiment 7: Digital pH Indicator (RGB Method)

Aim:
To measure the pH of a solution using a digital pH indicator that works with RGB values.

Materials Required:
- Smartphone
- Prepared indicator solution
- URL: tinyurl.com/ssgr-ph

Procedure:
1. Open the given link on your device.
2. Place the test solution with universal indicator in proper lighting.
3. Click a picture, ensuring the solution is in the center of the frame.
4. The system automatically detects RGB values from the center.
5. Click "Check" to display the calculated pH.

Observation:
- RGB values: R = __, G = __, B = __
- Calculated pH = __

Result:
The digital system provides the pH of the solution based on RGB color analysis.